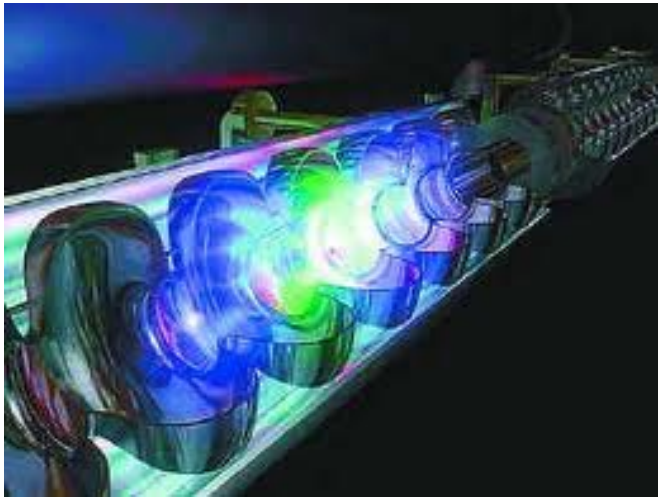
Results and Plans for April 2013

Start-to-End Simulations



Igor Zagorodnov

Deutsches Elektronen Synchrotron,
Hamburg, Germany

S2E Meeting, DESY
8. April 2013

HELMHOLTZ GEMEINSCHAFT

DESY

Plan/Results for March 2013

- FLASH simulations with Elegant and comparison with previous results (**done**)
- XFEL siulations with Elegant and for the whole machine (**0%**)
- New webpage design (**new s2e results**)
- New tools on the web (**0%**)
- ALICE 1.1 with intersections (**done, testing**)
- Make a talk at BD group meeting (**0%**)

Web Presence

FLASH

new! -> **FLASH beam dynamic simulations 500MeV/250pC (for U.Lorentz, Hasylab, 02.04.13) (PDF) ; data: 500MeV/250pC, (ZIP)**

FLASH beam dynamic simulations for different charges. 09/2010 (PDF) ; data: 1nC, 0.5nC, 0.25nC, 0.1nC, 0.02nC (ZIP)

ASTRA Simulations for the FLASH Injector (Jan. 2009)

Micro-Bunching Experiments 2008 at FLASH

Design version with 3.9 GHz cavity (6.4 nm, 1GeV)

Operation 2005 version without 3.9 GHz cavity : Case 0.5 nC, 4 ps sigma

old -> Operation without 3.9 GHz cavity : Case 1.0 nC, 4 ps sigma, velocity bunching

old -> Operation without 3.9 GHz cavity : Case 1.0 nC, 20 ps flat top, velocity bunching

XFEL

new! -> **250pC and 45 kA (for V. Kocharyan, 05.04.2013) (PDF) ; data: Genesis beam files with wakes (ZIP),**

new! -> **1nC and 10 kA (for V. Kocharyan, 03.04.2013) (PDF) ; data: Genesis beam file with wake (TXT), ASTRA files (ZIP)**

new! -> **30pC with all wakes (for V. Kocharyan, 03.05.2011) (PDF) ; data: Genesis beam file with wake (TXT), ASTRA files (ZIP)**

new! -> **100pC with all wakes (for M. Yurkov, 20.03.2011) (PDF) ; data: Genesis beam file with wake (TXT), ASTRA files (ZIP)**

Beam Dynamics Simulations for XFEL (Jan. 2011) (PDF, PPT) ; data: 0.02 nC, 0.1 nC, 0.25 nC, 0.5 nC, 1 nC (ZIP)

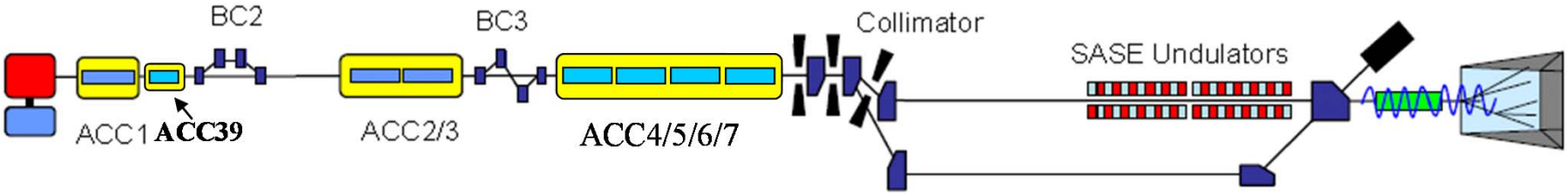
Start-to-End Simulation for the European XFEL 2006

old -> ESFRI XFEL workshop, October 2003 (20.0 GeV, double chicane, 5 kA)

old -> Benchmark S2E workshop, August 2003 (20.5 GeV, 3 chicanes, 12 kA peak)

FLASH simulations with Elegant

Technical constraints and choosing of machine parameters



$$15 \le \frac{\theta_1}{\text{grad}} \le 21$$

$$1.7 \le \frac{\theta_1}{\text{grad}} \le 5.4$$

$r_{56} \approx 0 \ldots -0.56$ mm

$V_1 \le 165$ MV

$V_{39} \le 22$ MV

$V_2 \le 345$ MV

$V_3 \le 750$ MV

FLASH simulations with Elegant

How to proceed?

1. Define energy profile

$$E_{gun} \approx 5\,[\mathrm{MeV}]$$

$$E_{BC_2} = E_{gun} + 0.95\frac{8}{9}\max E_1 \approx 145\,[\mathrm{MeV}]$$

$$E_{BC_3} = E_{BC_3} + 0.9\max E_2 \approx 450\,[\mathrm{MeV}]$$

2. ASTRA simulation of the gun with ACC1 (z=14.6102)

$$eV_1 = \frac{9}{8}\left(E_{BC_2} - E_{gun}\right) \approx 157.5\,[\mathrm{MeV}] \qquad \varphi_1 = 0$$

3. Fast longitudinal dynamics simulations

I. Zagorodnov, M. Dohlus, PR STAB, 2011

4. ASTRA, CSRtrack and Elegant simulations

FLASH simulations with Elegant

Working points (8 macroparameters)

Charge Q, nC	Energy in BC2 E_1, [MeV]	Energy in BC3 E_2, [MeV]	Deflecting angles $teta_1$, [grad]	Deflecting radius in BC3 $teta_2$, [grad]	Compression in BC2 C_1	Total compression C	First derivative Z_2', [m^{-1}]	Second derivative Z_2'', [m^{-2}]
1	145	450	18	4.5	4	48	0	3e3

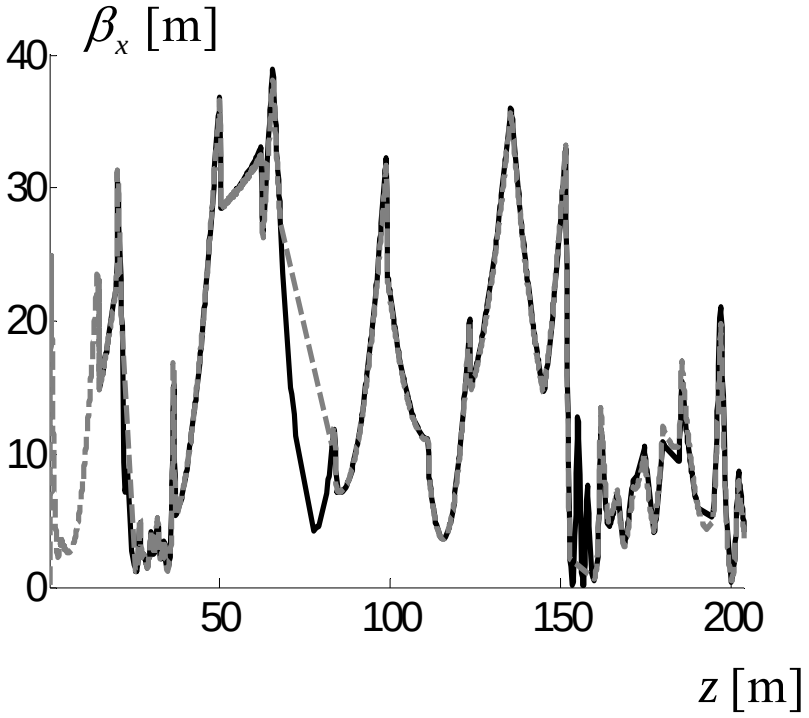
FLASH simulations with Elegant

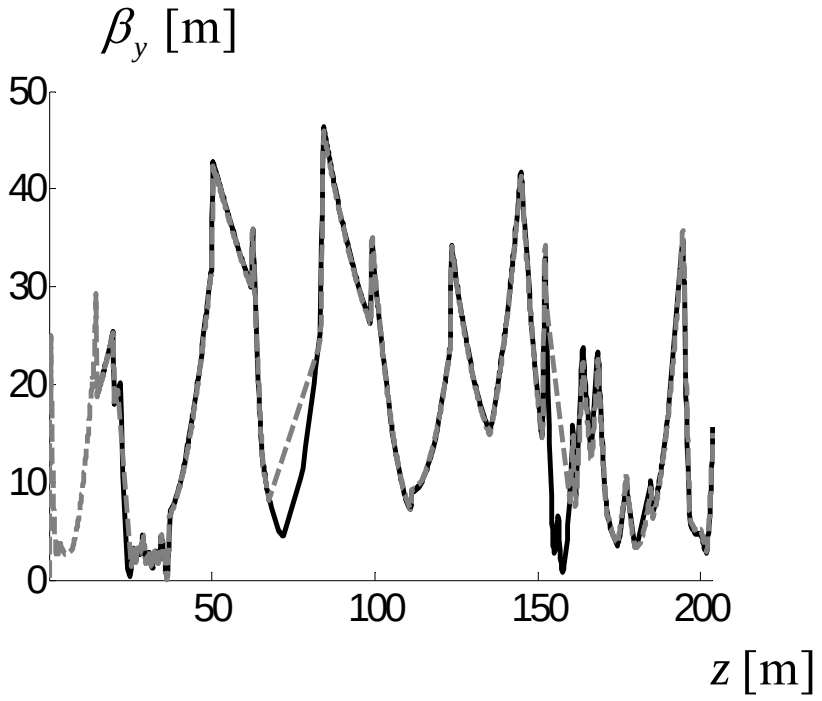
RF settings in accelerating modules (without self fields)

Charge, nC	$V_{1,1}$, [MV]	$\varphi_{1,1}$, [deg]	$V_{1,3}$, [MV]	$\varphi_{1,3}$, [deg]	V_2, [MV]	φ_2, [deg]
Track1D	162.41	9.34	20.32	183.17	332.67	23.53
Elegant	162.41	9.34	20.32	183.17	332.51	23.47
ASTRA	162.47	9.41	20.32	183.17	332.41	23.41

FLASH simulations with Elegant

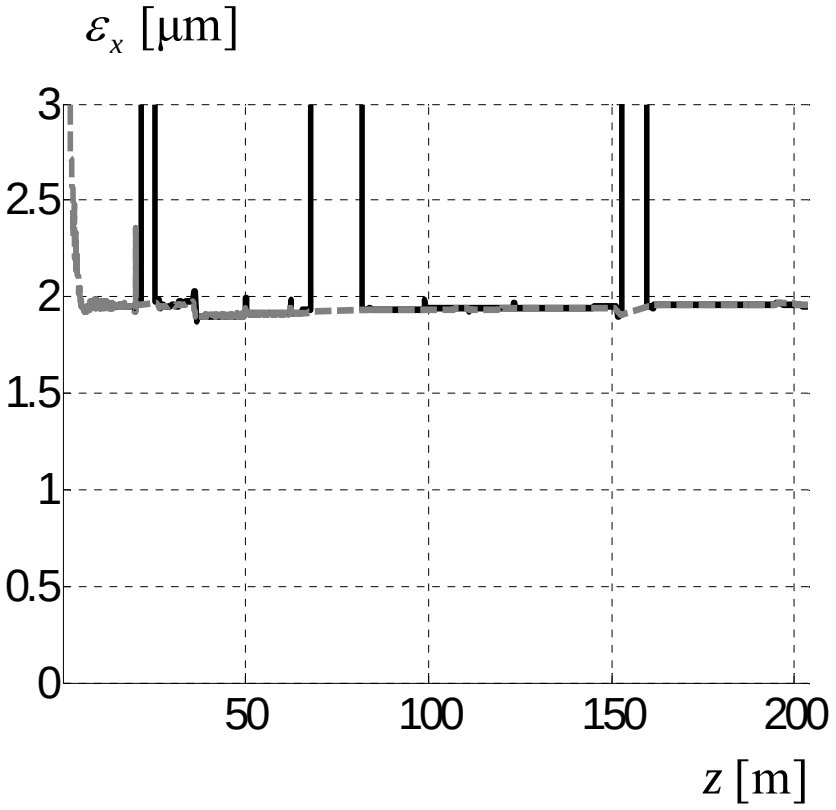
Elegant vs ASTRA without self-fields

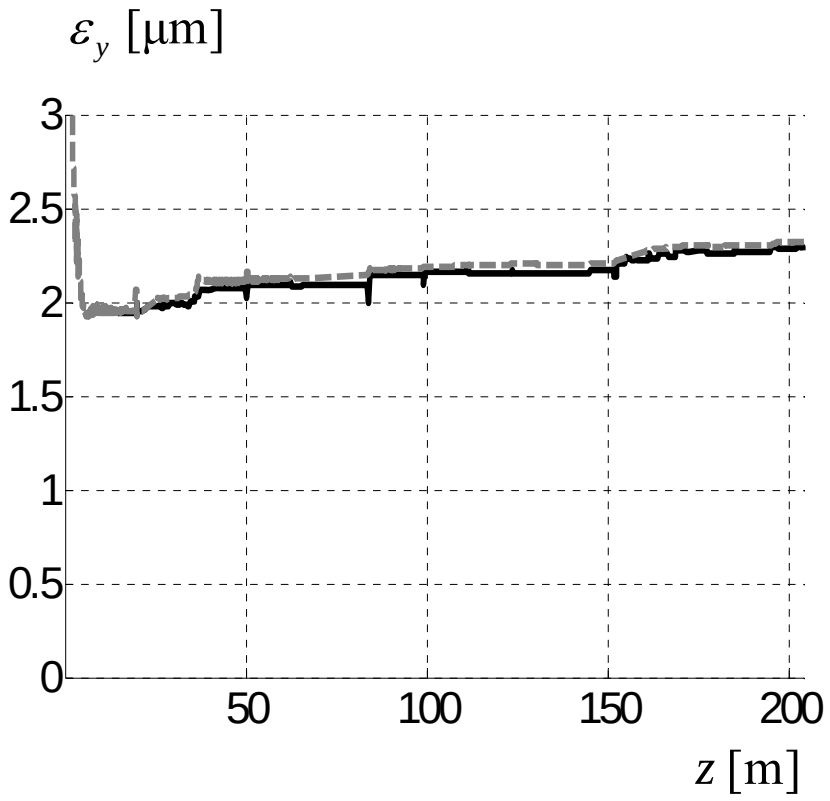




FLASH simulations with Elegant

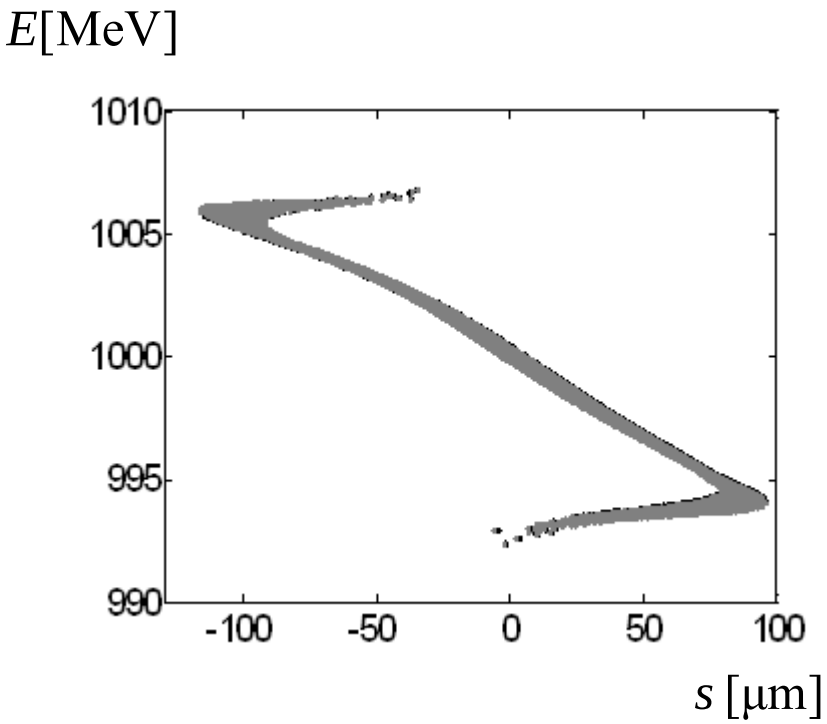
Elegant vs ASTRA without self-fields

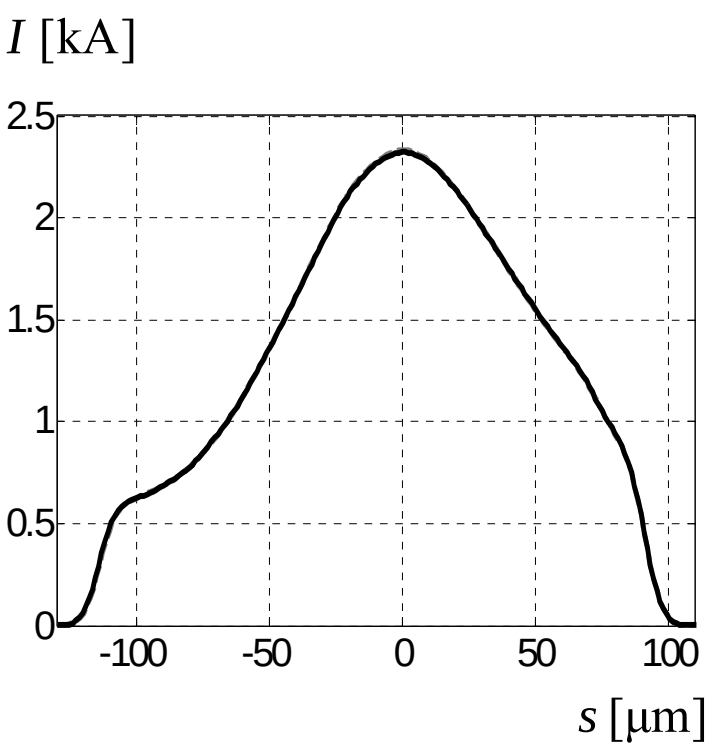




FLASH simulations with Elegant

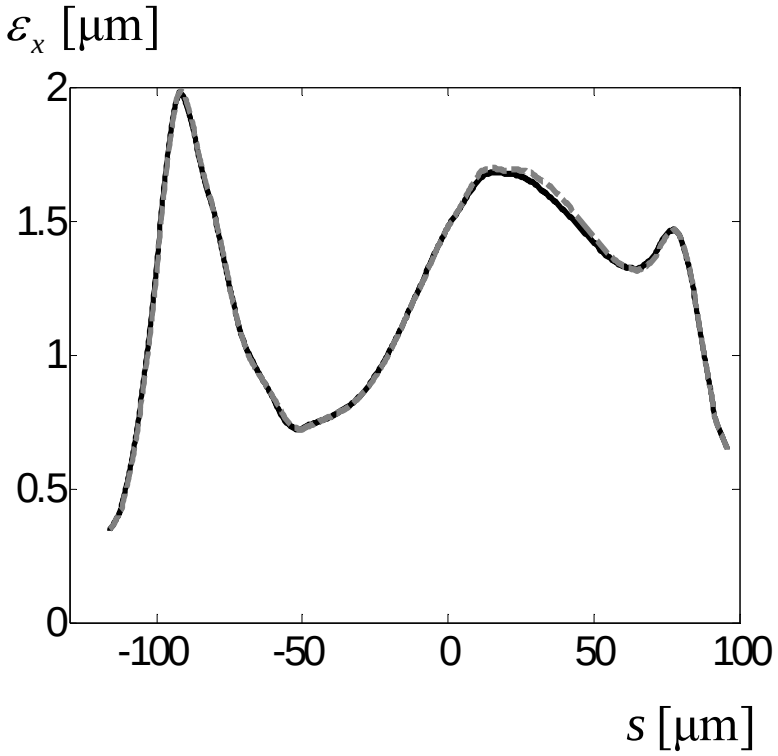
Elegant vs ASTRA without self-fields

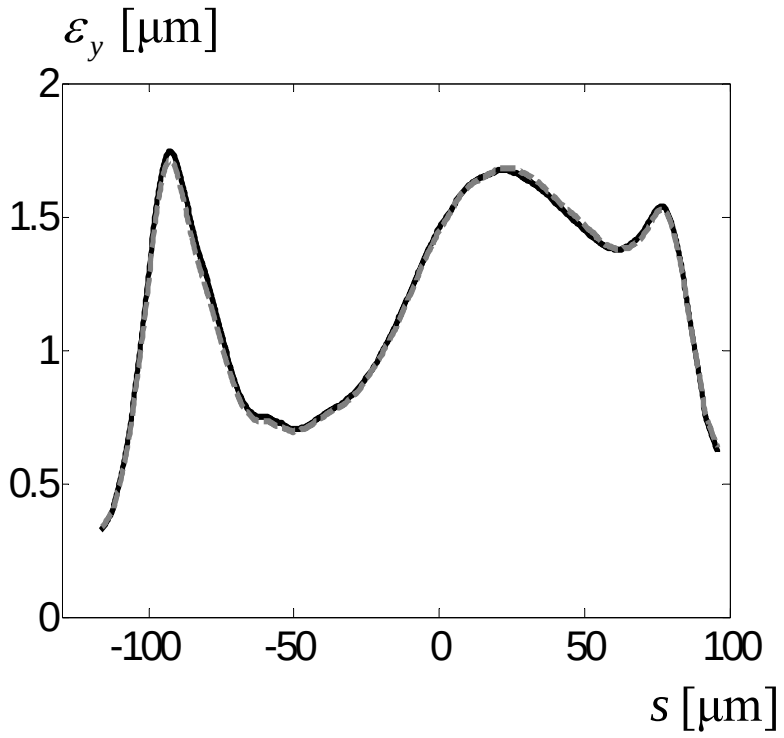




FLASH simulations with Elegant

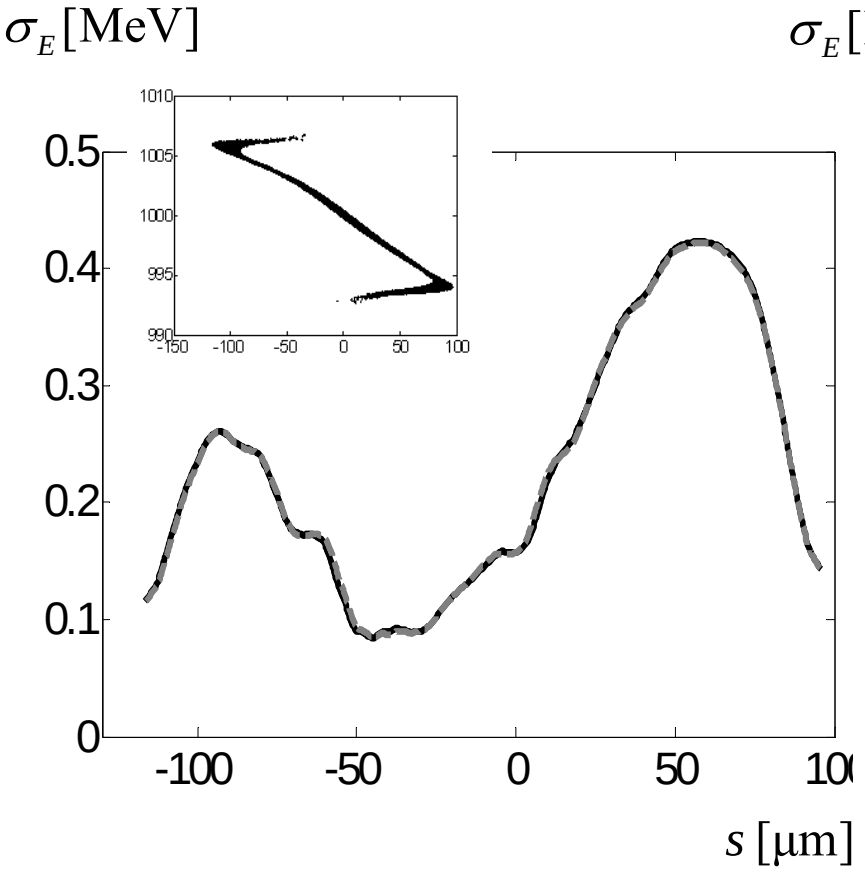
Elegant vs ASTRA without self-fields

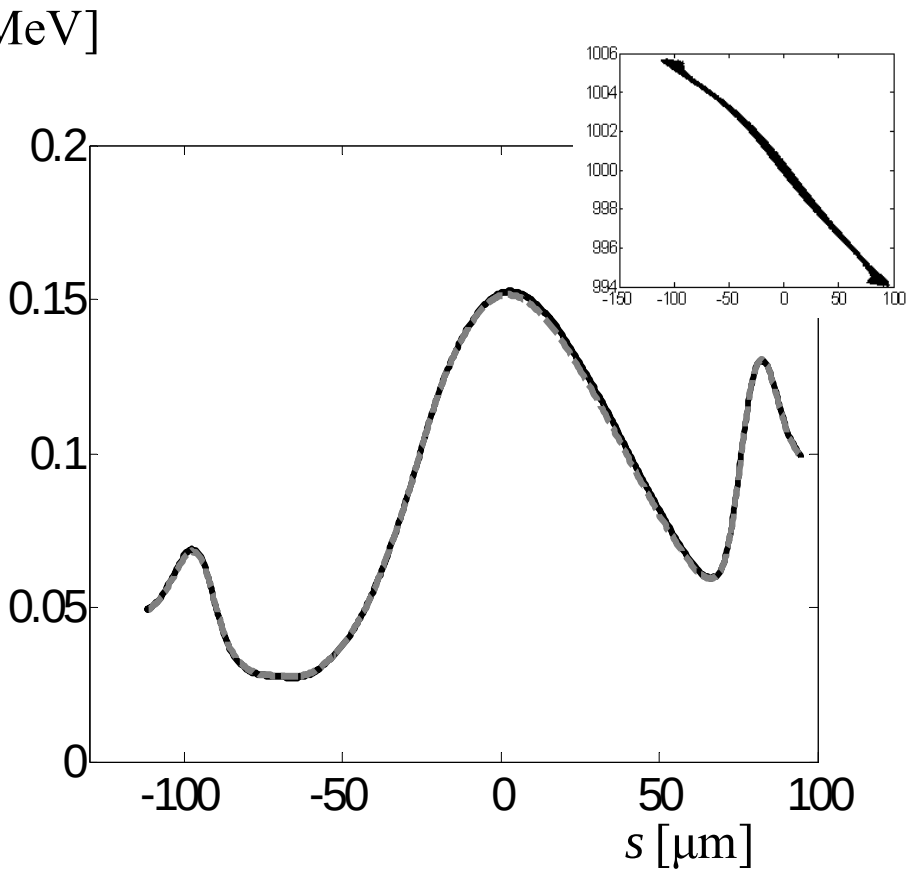




FLASH simulations with Elegant

Elegant vs ASTRA without self-fields





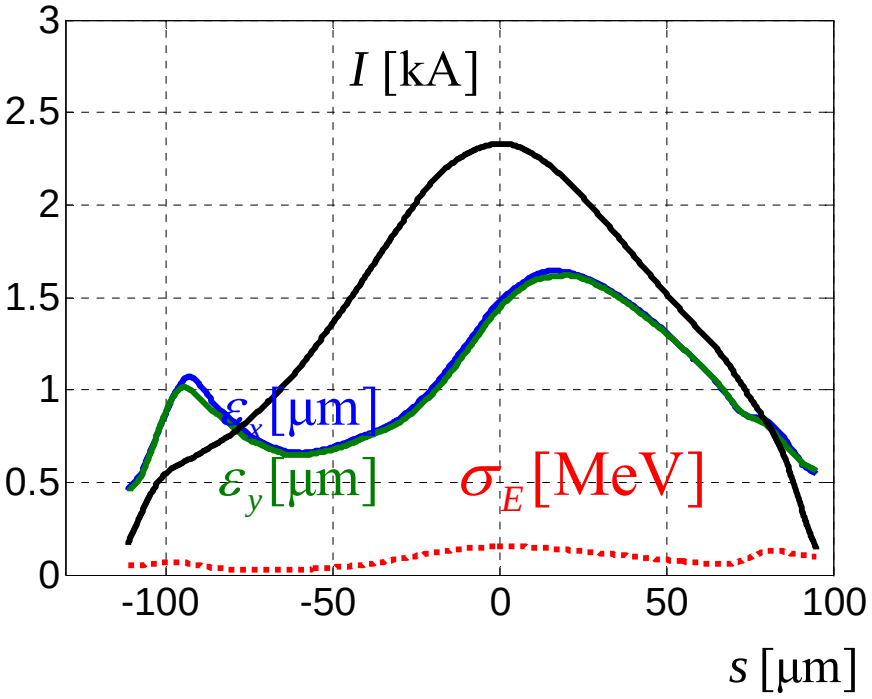
FLASH simulations with Elegant

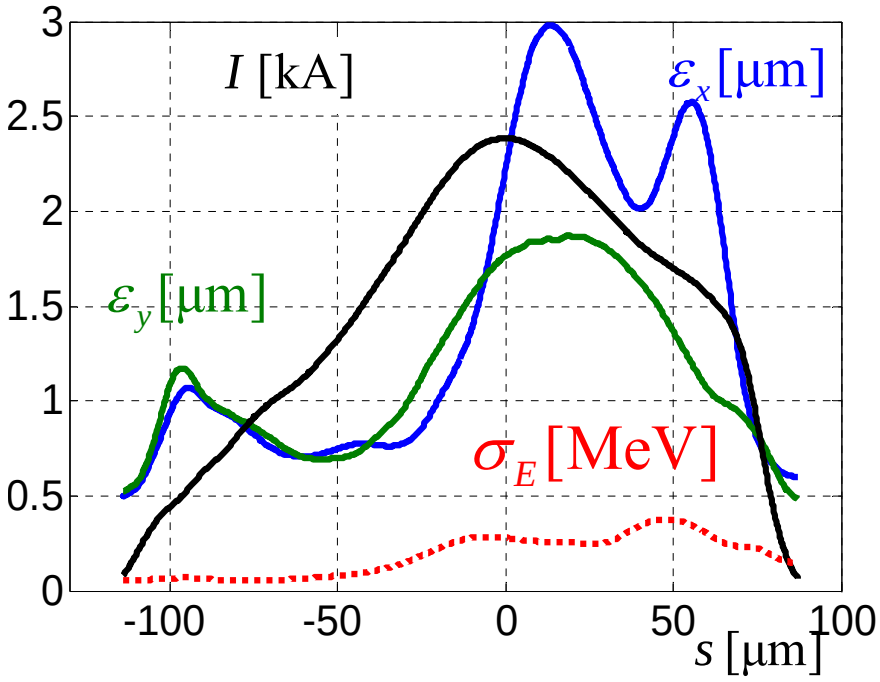
RF settings in accelerating modules (with self fields)

Charge, nC	$V_{1,1}$, [MV]	$\varphi_{1,1}$, [deg]	$V_{1,3}$, [MV]	$\varphi_{1,3}$, [deg]	V_2, [MV]	φ_2, [deg]
Track1D (without)	162.41	9.34	20.32	183.17	332.67	23.53
Track1D (selffield)	157.81	-3.92	20.81	145.89	339.19	25.86
Elegant	157.81	-3.92	20.81	145.90	339.01	25.79
ASTRA	157.84	-3.96	20.81	145.92	338.42	25.58

FLASH simulations with Elegant

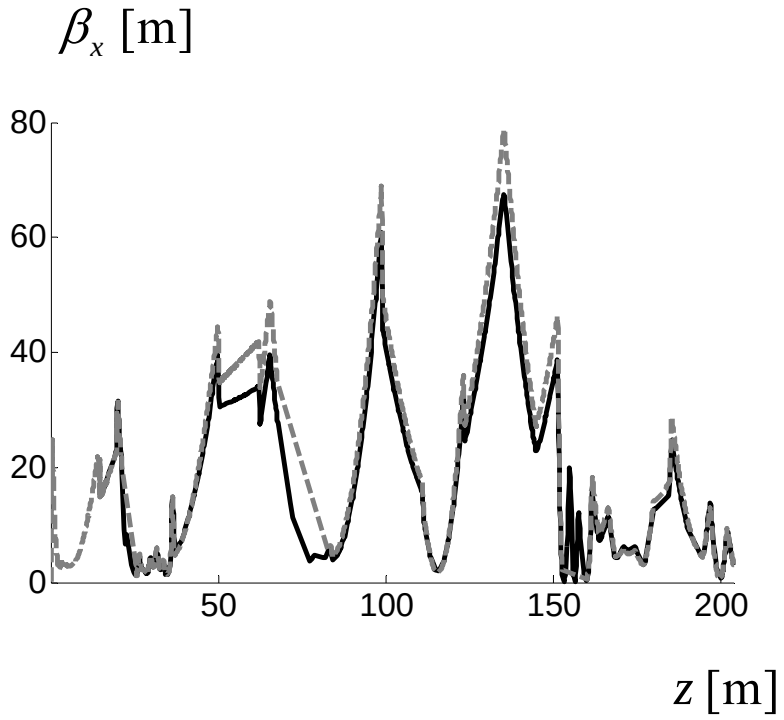
ASTRA without and with self-fields

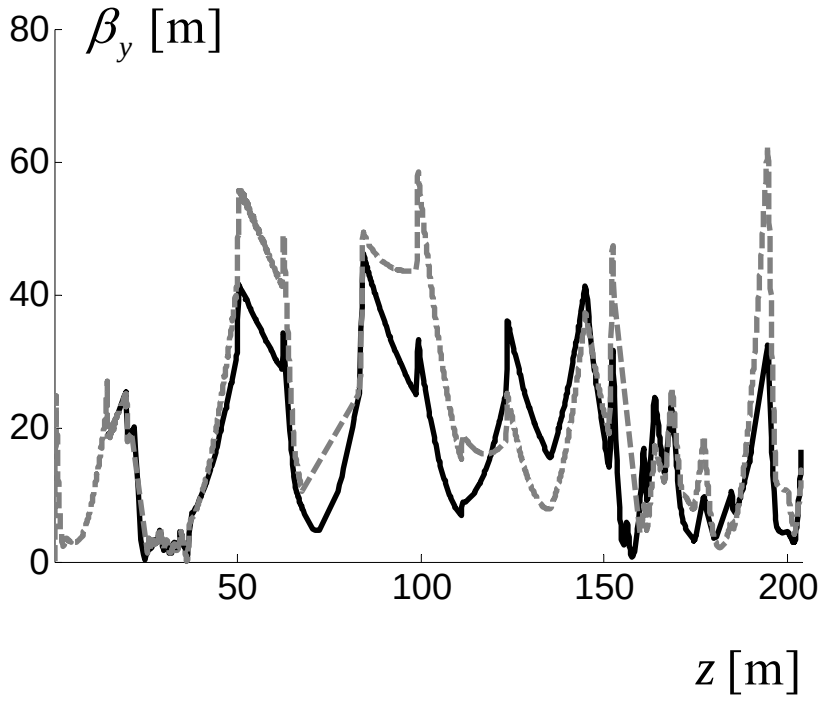




FLASH simulations with Elegant

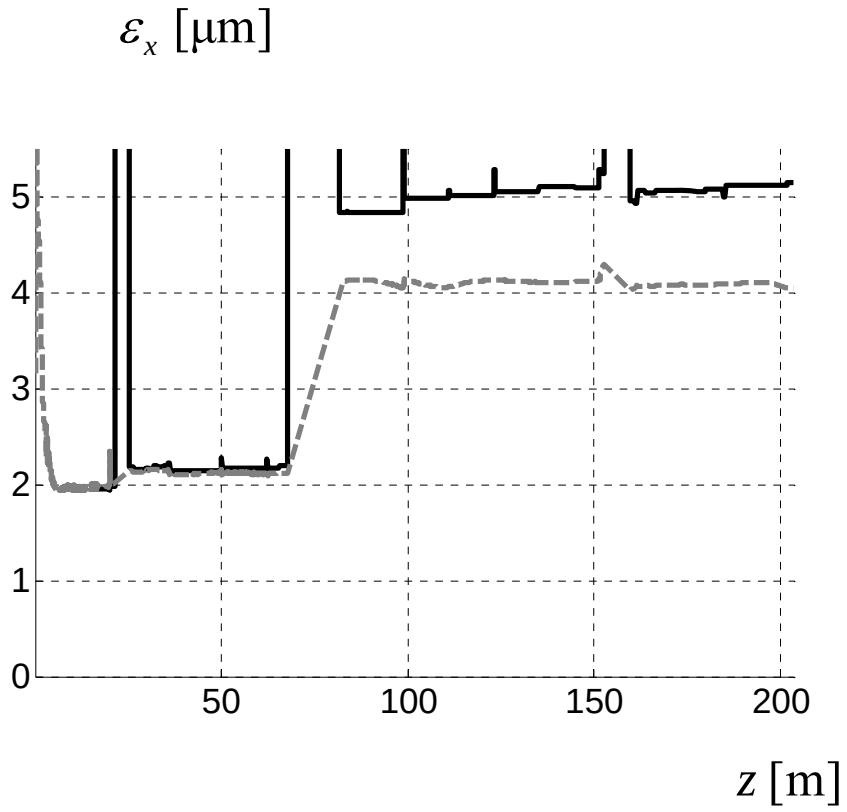
Elegant vs ASTRA with self-fields

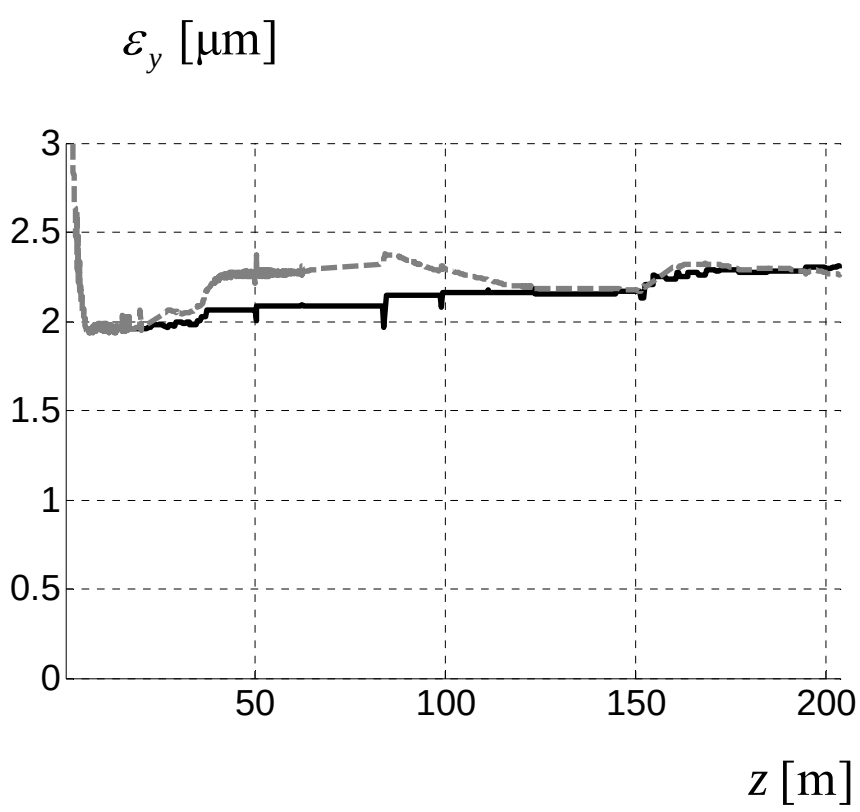




FLASH simulations with Elegant

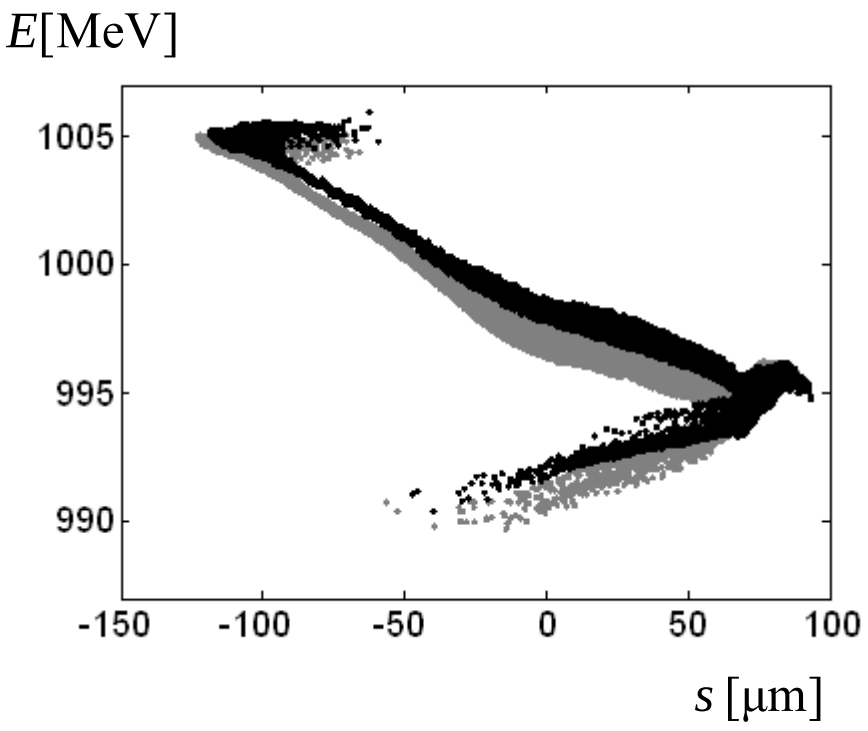
Elegant vs ASTRA with self-fields

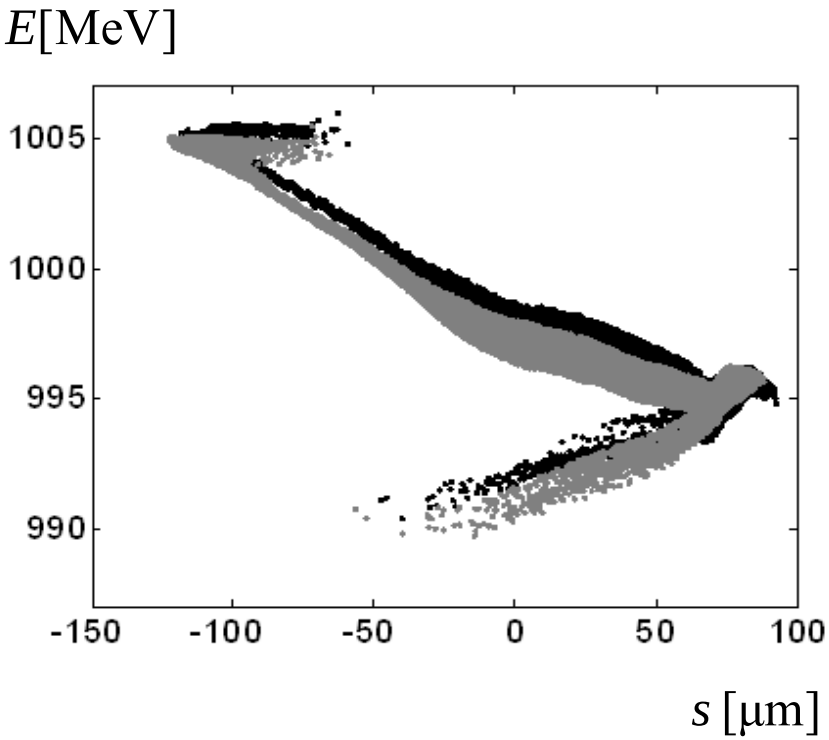




FLASH simulations with Elegant

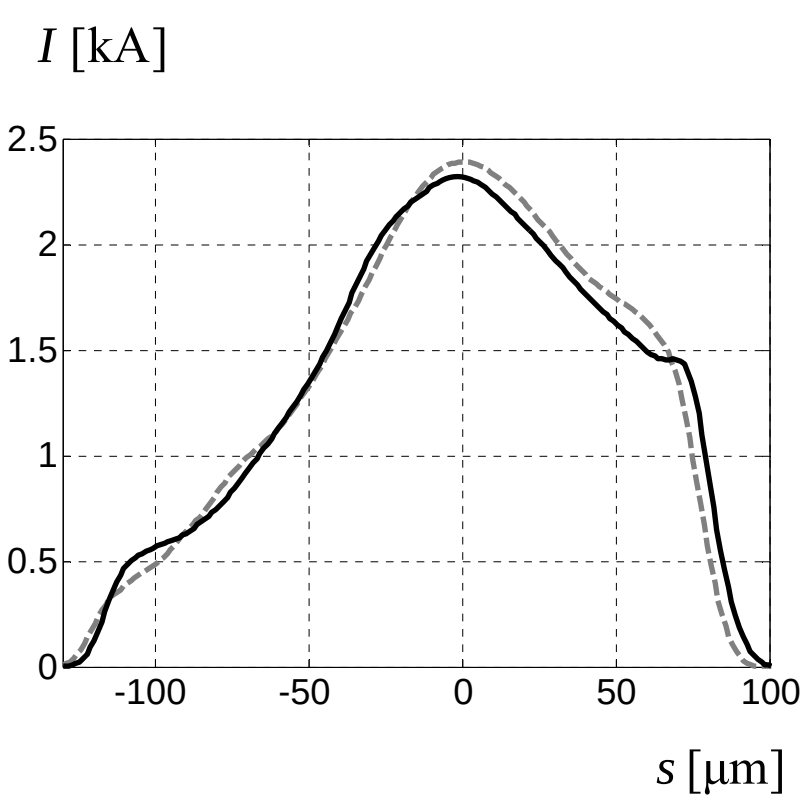
Elegant vs ASTRA with self-fields

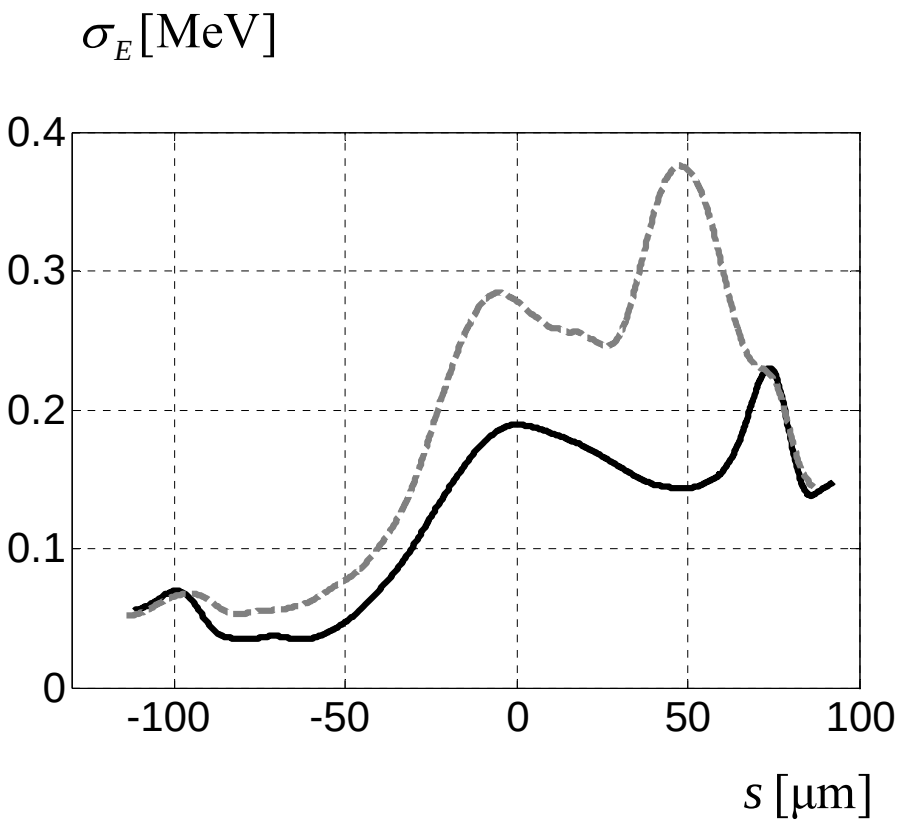




FLASH simulations with Elegant

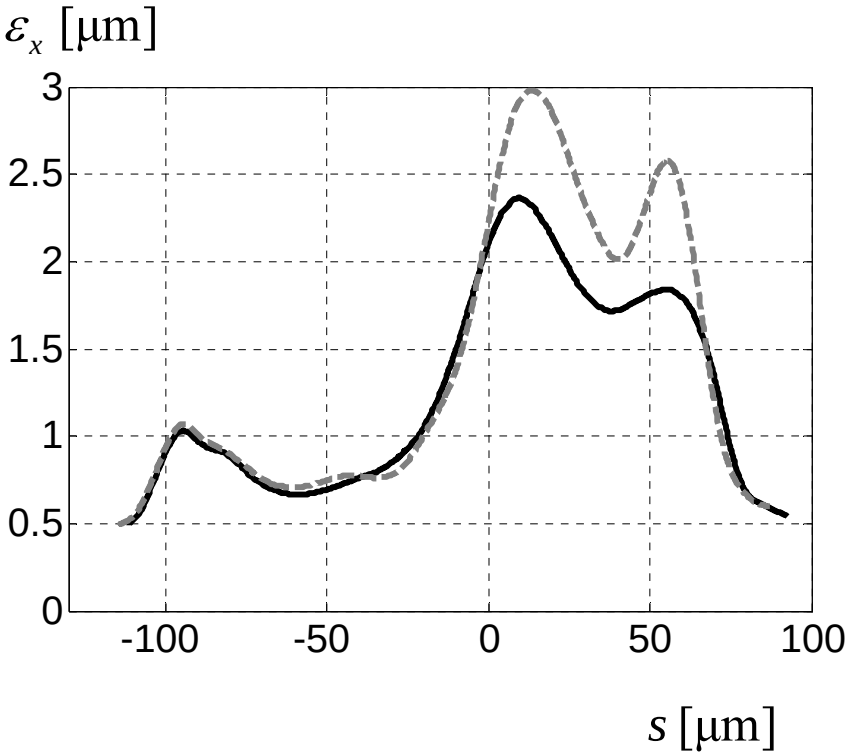
Elegant vs ASTRA with self-fields

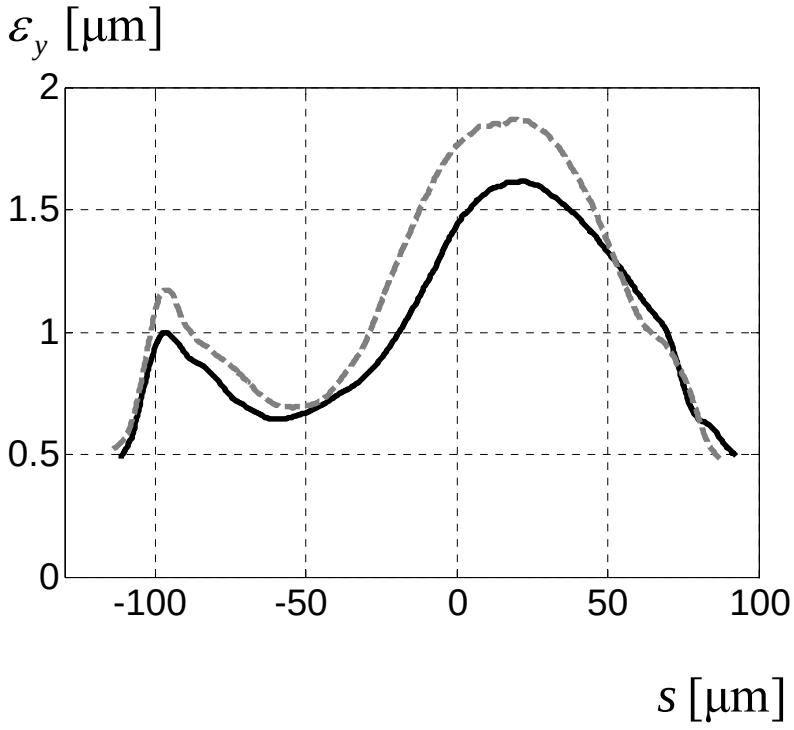




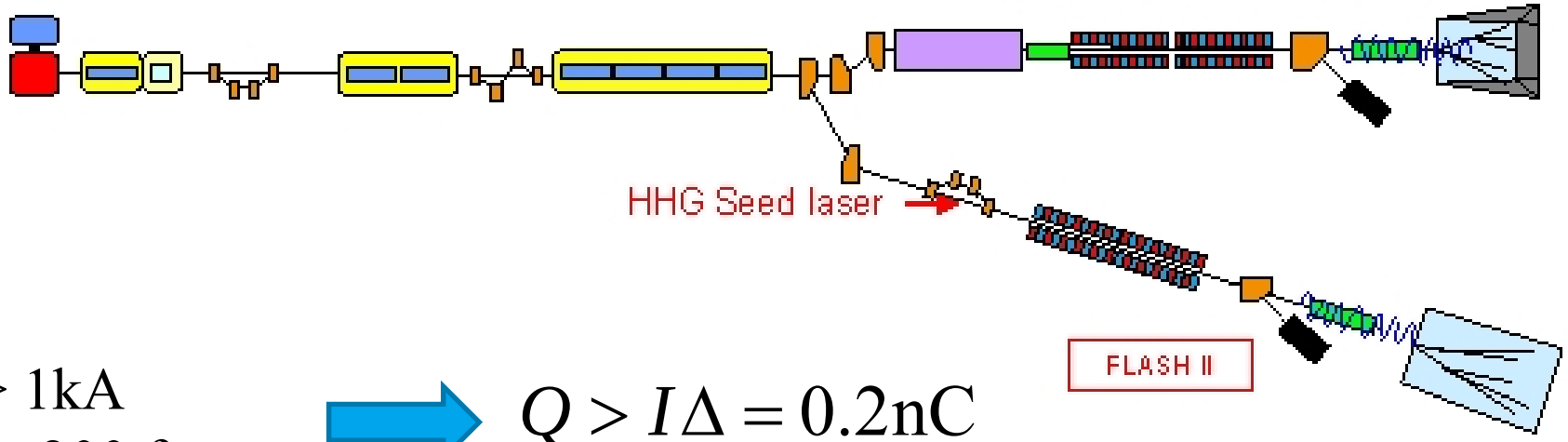
FLASH simulations with Elegant

Elegant vs ASTRA with self-fields





Low energy spread for FLASH II

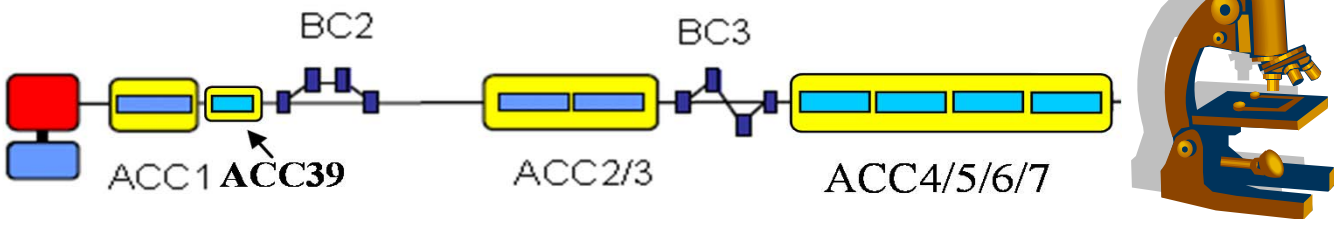


$I > 1\text{kA}$

$\Delta > 200\ \text{fs}$

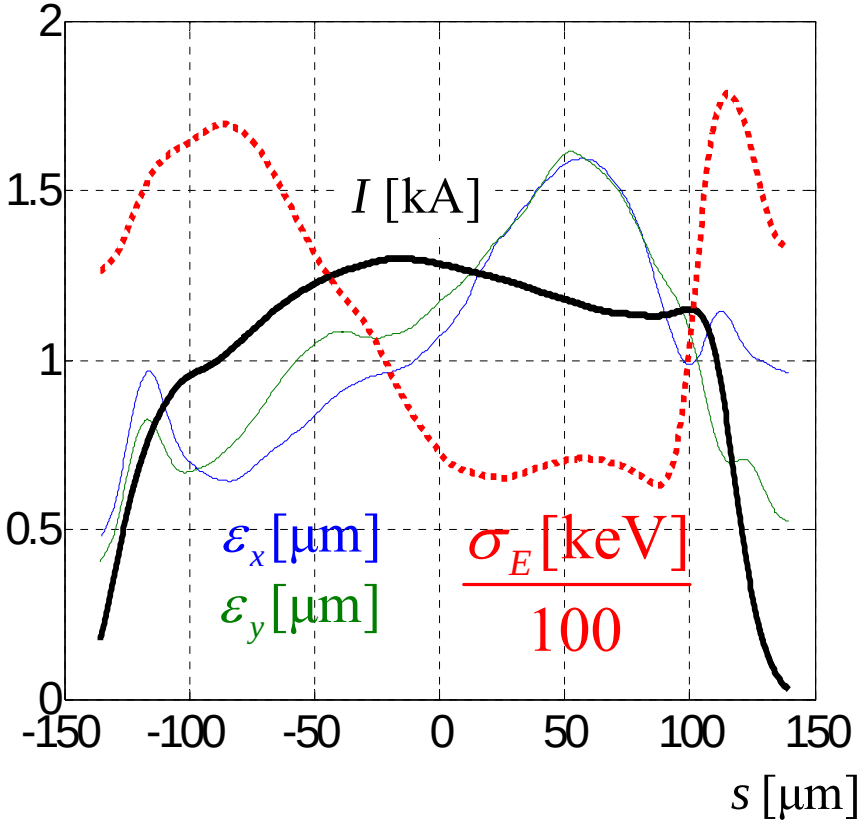
$$Q > I\Delta = 0.2\text{nC}$$

Energy spread < 120keV

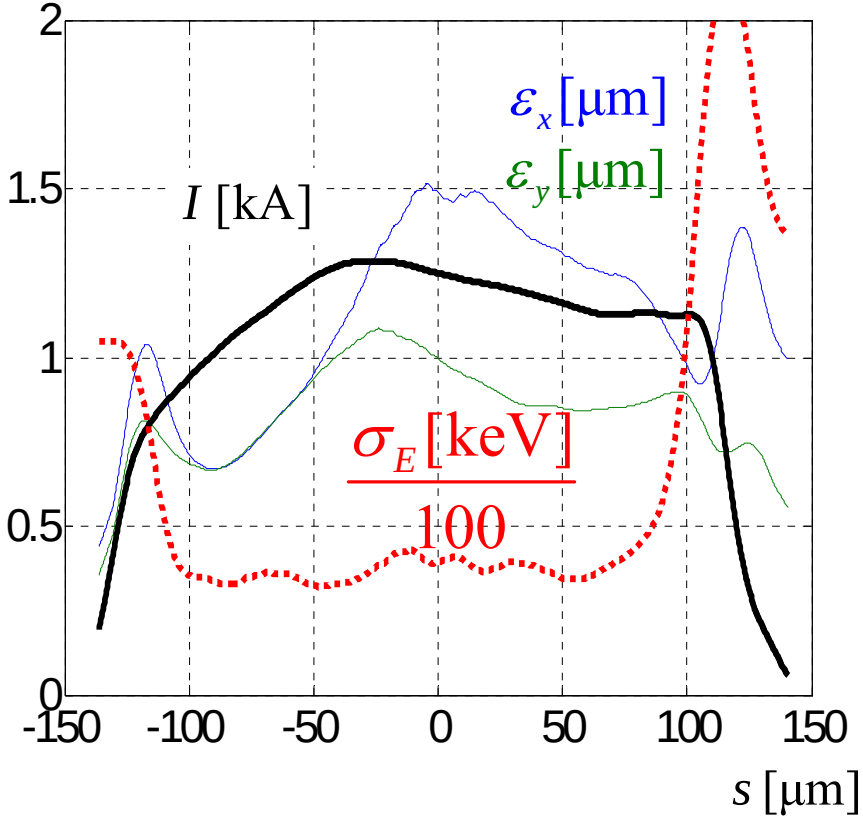


Low energy spread for FLASH II

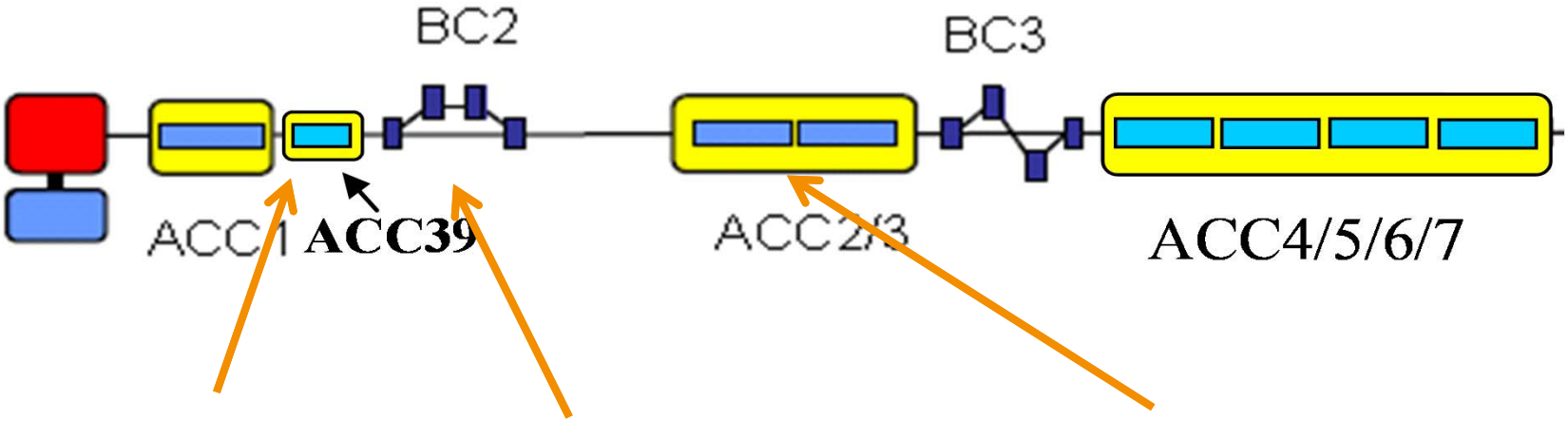
ASTRA/CSRtrack

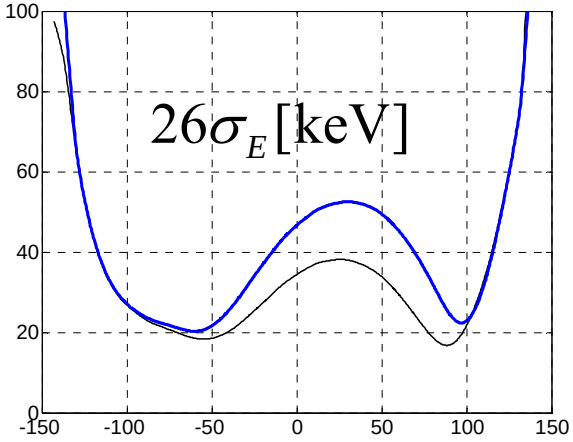


Elegant

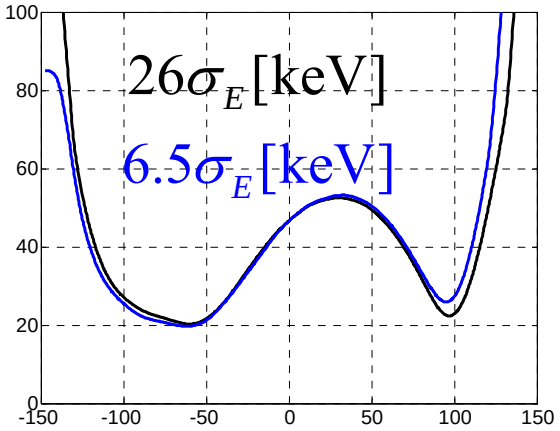


Low energy spread for FLASH II

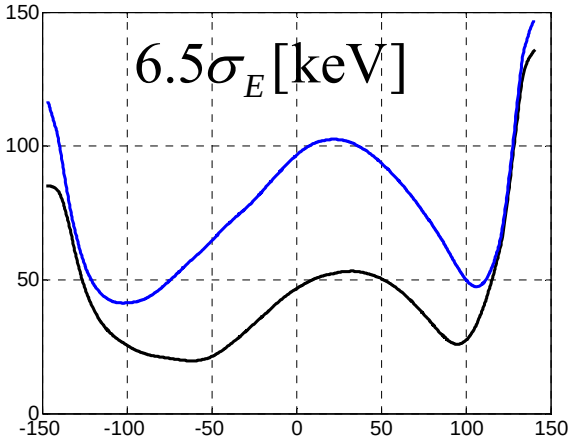




$$\frac{s\,[\mu m]}{26}$$

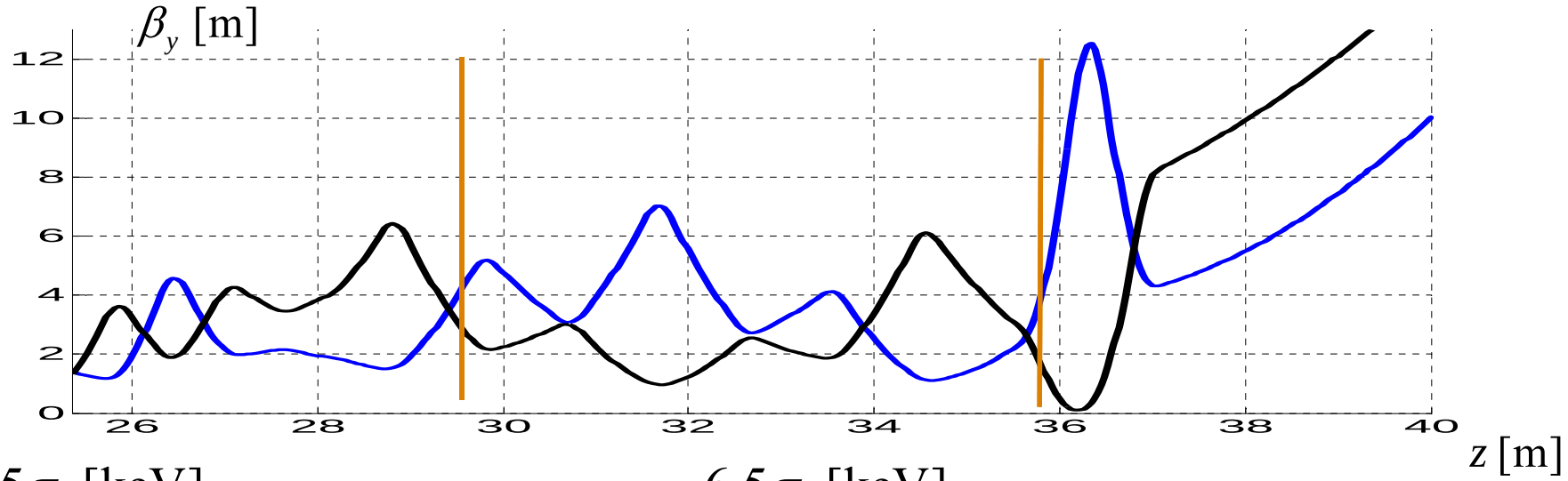


$$\frac{s\,[\mu m]}{26} \qquad \frac{s\,[\mu m]}{6.5}$$

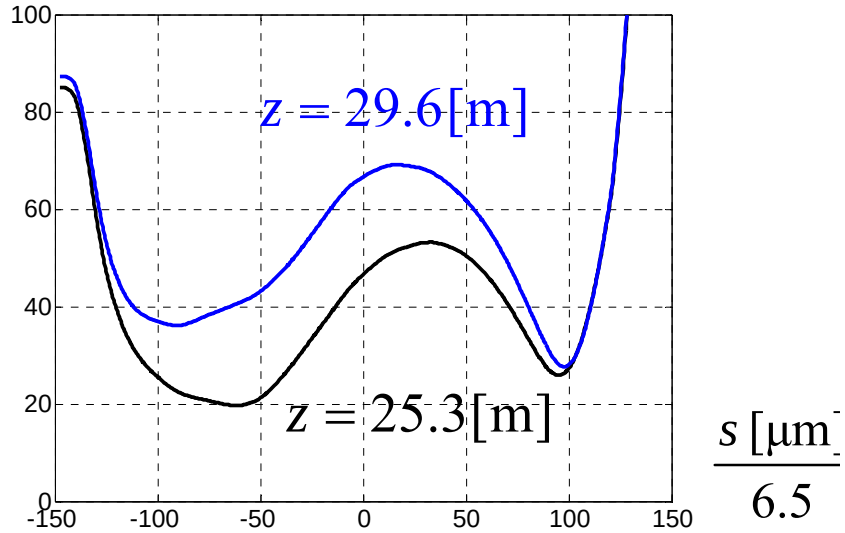


$$\frac{s\,[\mu m]}{6.5}$$

Low energy spread for FLASH II

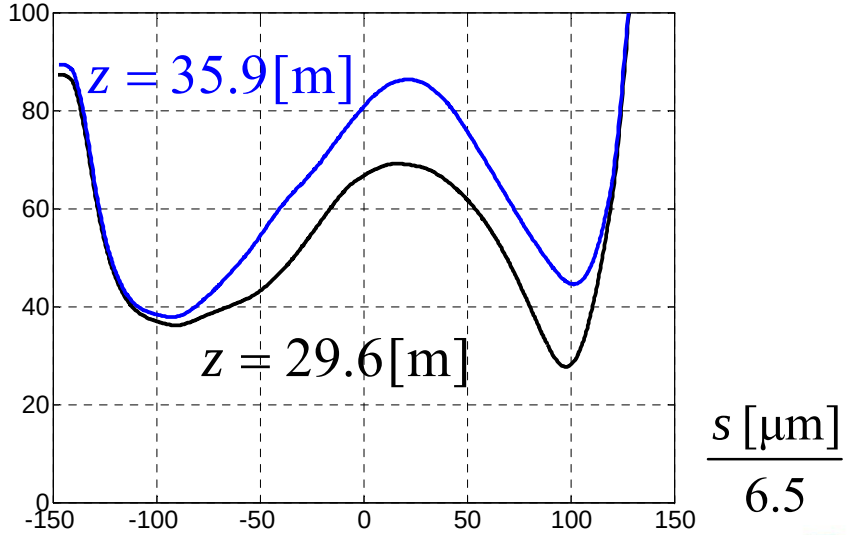


$6.5\sigma_E$[keV]



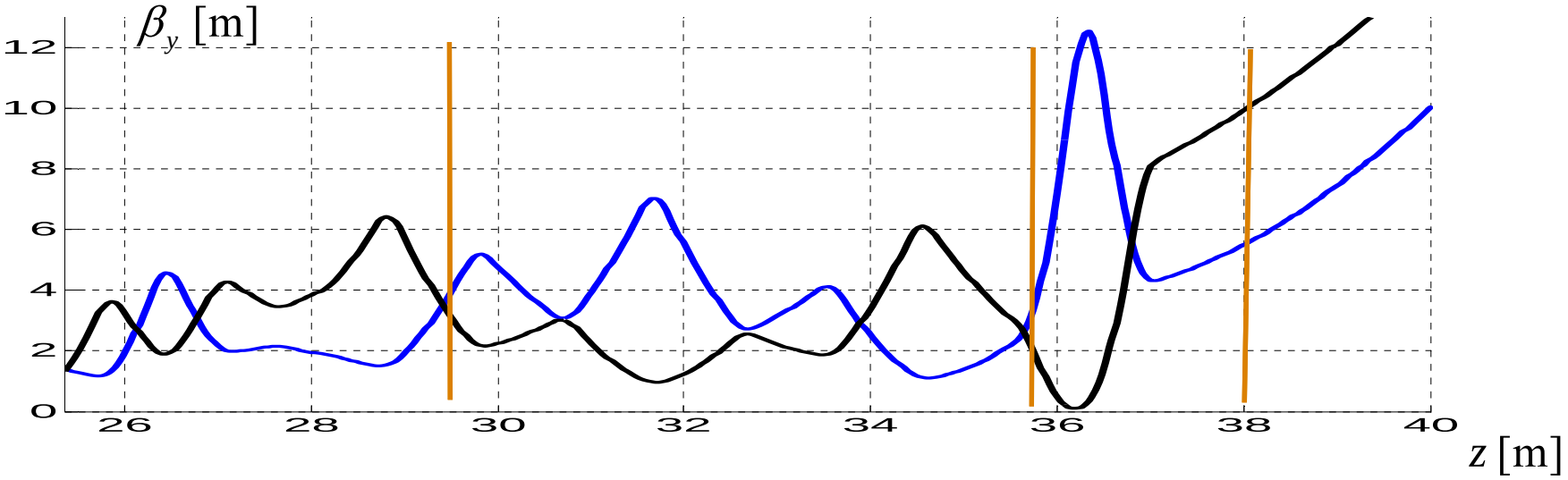
$\frac{s\,[\mu m]}{6.5}$

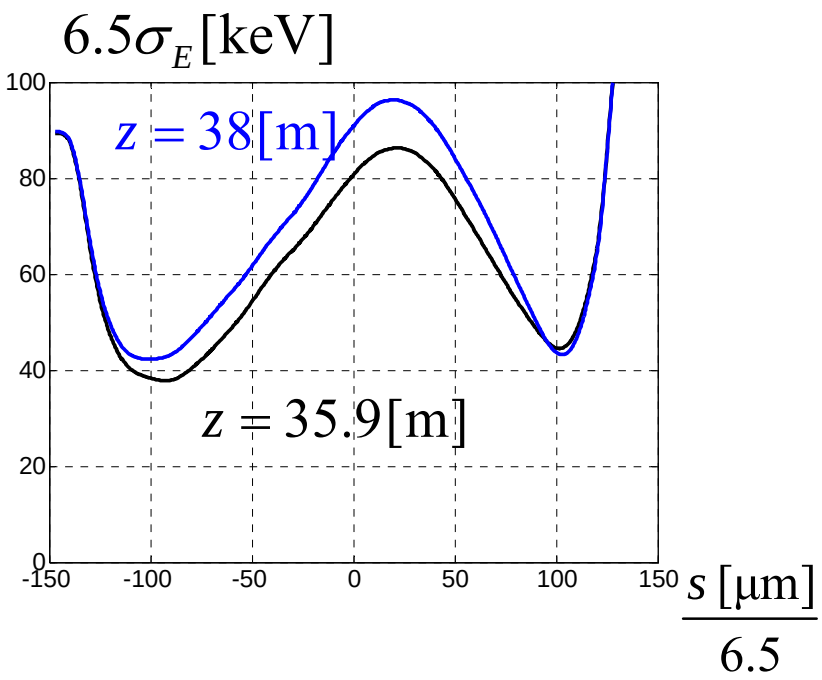
$6.5\sigma_E$[keV]

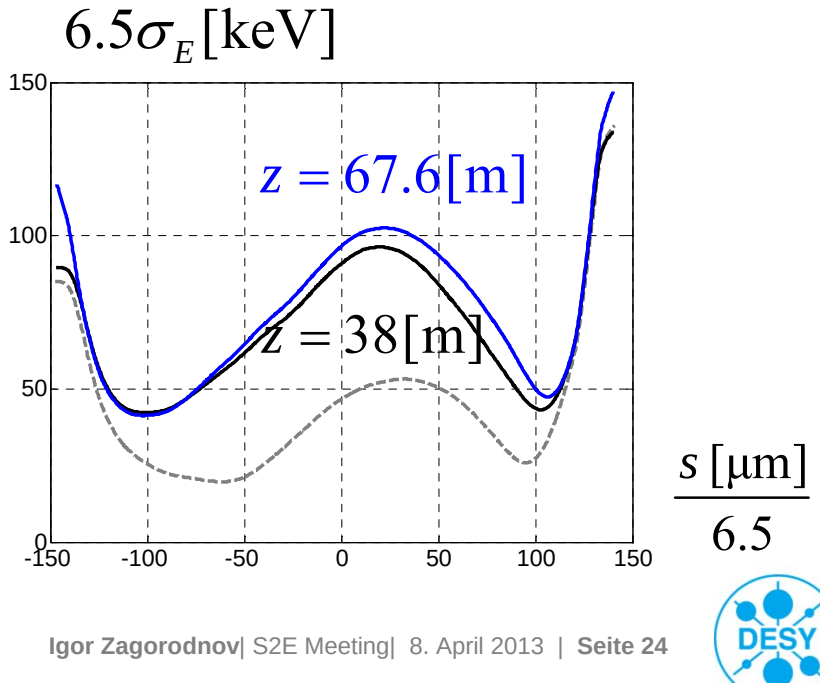


$\frac{s\,[\mu m]}{6.5}$

Low energy spread for FLASH II







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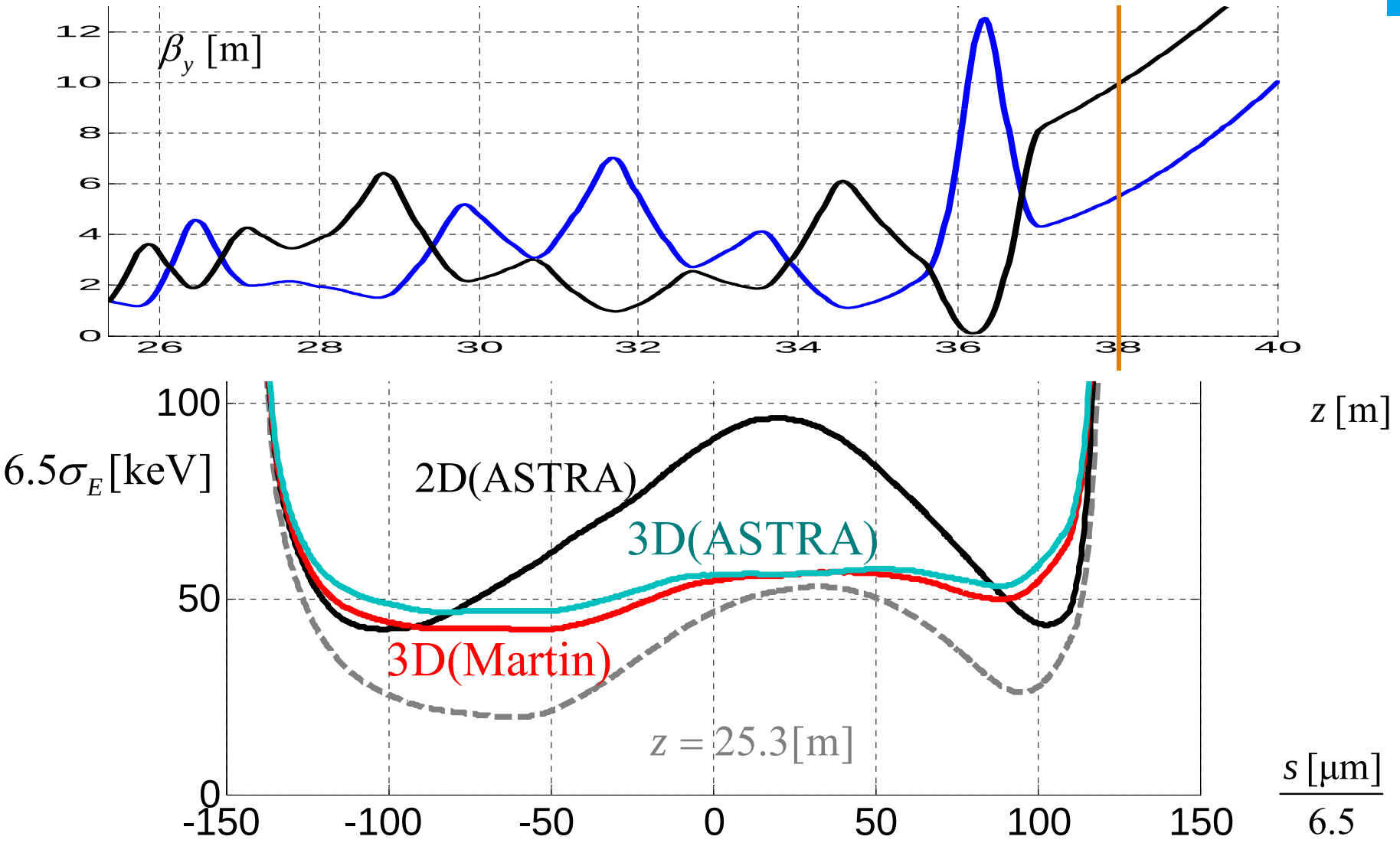

Plan April 2013

- FLASH simulations for low energy spread
- XFEL siulations with Elegant and for the whole machine
- Webpage design
- ALICE 1.1 with intersections, testing

The next meeting on 6 May 2013